a hexose phosphate containing two phosphoric acid residues. The evidence is based largely on the composition of the barium salt of the compound, and on the behavior of its ozazones. In the formation of the ozazone, a single phosphoric acid molecule is split off, while the ozazone also contains a phosphoric acid residue.

It has been known that yeasts are able to ferment a number of substances other than sugars. The number of such substances which undergo a kind of fermentation accompanied by the evolution of carbon dioxide has been greatly extended by NEUBERG and TIR.[28] The substances which are fermented in this way by yeasts and yeast preparations are the common plant acids which occur naturally in fruit juices and other substances used in alcohol production, and also components or products of the yeast cell, as fatty acids, glycerine, and lecithin.—H. HASSELBRING.

Soil productiveness indicated by natural vegetation.—The practical object of SHANTZ's Bulletin[29] on "Natural vegetation as an indicator of the capabilities of land for crop production in the Great Plains area" does not detract from its scientific value. It is an interesting and valuable example of the application of exact ecological research methods, with results establishing reliable data relating to the natural vegetation of a given region, and its correlation with the crop-producing capabilities of the land. Detailed investigations were made in Washington and Yuma Counties, Eastern Colorado, although a general survey included all the states of the Great Plains, a region containing the largest body of land of possible agricultural importance in the United States on which the native plant cover still exists. The methods included study of the vegetation with respect to the formations, dominant associations, and important species, and of the various determining factors with especial consideration of the physical conditions (temperature, rainfall, evaporation, saturation deficit, soil moisture, soil temperature, etc.). Records for these physical factors were made at 11 different stations on the Great Plains, under direction of BRIGGS, and supplemented by SHANTZ with many comparative observations. For purposes of comparison, the soil moisture determinations were reduced to definite standards, as moisture equivalent and non-available moisture (for Kubanka wheat).

Plant migrations, invasions, effects of fire, grazing, mowing, and other biotic agencies are considered. Illustrations of the root systems of significant species are given and their relations to the soils and in the successions are noted. Indicative of agricultural land are the grama-buffalo grass and the wire grass

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[28] NEUBERG, C., and TIR, L., Ueber zuckerfreie Hefegärungen. II. Biochem. Zeitschr. **32**:323–331. 1911.

[29] SHANTZ, H. L., Natural vegetation as an indicator of the capabilities of land for crop production in the Great Plains area. Bur. Pl. Ind. Bull. no. 201. pp. 100. *pls. 6. figs. 23.* 1911.

associations (both short grasses), also bunch grass and sand hills mixed (prairie grasses). Each of these types is characterized as to general appearance, floristic composition, correlated physical factors, effects of disturbing factors, variations from the typical association. The relationships and successions of the different associations are outlined, primary and secondary successions being recognized, though these do not appear to be fundamentally distinct. The remainder of the bulletin is concerned with crop production in the light of the data obtained, with practical suggestions as to the choice of land and to methods of culture.—LAURA GANO.

Embryo sac of Pandanus.—In 1908, CAMPBELL published a preliminary note on the embryo sac of *Pandanus*, and in 1909 a fuller paper appeared.[30] Now a third paper has appeared,[31] based upon material that shows the completed structures of the sac. Three species are included (*P. Artocarpus*, *P. odoratissimus*, and *P. coronatus*), so that the results may be regarded as fairly representative of the genus.

The primary sporogenous cell (overlaid by several layers of parietal cells) divides into a large inner cell and a smaller outer one, the latter dividing again. The embryo sac is developed by the innermost cell, which thus represents two megaspores. The usual divisions occur to the 4-nucleate stage (a pair of nuclei at each pole of the sac). The micropylar pair divides, and there is organized a normal egg apparatus and its attendant polar nucleus. Before this occurs, however, the two antipodal nuclei initiate a series of free nuclear divisions, accompanied later by wall-formation, until finally 64 or more antipodal cells may be formed before fertilization occurs. A variable number of antipodal nuclei are free and fuse with the micropylar polar nucleus to form a single large endosperm nucleus, or two such endosperm nuclei may be formed by the multiple fusions. In the formation of endosperm by the usual stages of free nuclear division, wall-formation, and centripetal growth, the author states that the "endosperm nuclei diminish in size as division proceeds, and this diminution in size is accompanied by a corresponding reduction in the number of chromosomes," although no count seems to have been made.

The excessive amount of antipodal tissue preceding fertilization certainly suggests that the antipodal cells are to be regarded as representing the vegetative tissue of the gametophyte, and so far as this feature is concerned, it seems safe to assume that it is primitive. In the organization of the egg-apparatus, however, it is not so much a question of the number of cells in the sac at the time of fertilization, as the number of divisions between the megaspore nucleus and the egg. In this case, since two megaspore nuclei are involved, there are just two successive divisions between a megaspore nucleus and the egg derived from it, instead of the usual three divisions.—J. M. C.

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30 BOT. GAZ. **47**:485. 1909.

31 CAMPBELL, D. H., The embryo sac of *Pandanus*. Ann. Botany **25**:773–789. *pls. 59, 60. figs. 2.* 1911.